XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

EFFECTIVE DATE: June 26, 1996 **EDITION NO.**: 1

MANUFACTURER AND MODEL:

Make:	*Scitec Corporation*
Model:	*MAP 4*
Source:	Co^{57}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from an EPA/HUD evaluation using archived building components. Testing was conducted on approximately 150 test locations. All of the test locations were tested in February 1996 using two different instruments. One instrument had a new source installed in July 1994 and its strength at the time of testing was calculated as 9.4 mCi. The other instrument had a new source installed in September 1994 and its strength at the time of testing was calculated as 10.6 mCi.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrument under the same conditions as the evaluation testing and using the procedures described in Chapter 7 of the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Take readings on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken in test mode while using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Readings for determining the substrate correction values are taken on bare substrate covered with red (1.02 mg/cm^2) NIST SRM paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2.

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XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. For this instrument, calibration checks should be taken in TEST mode. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

minus value = -0.4 mg/cm^2
plus value = +0.2 mg/cm^2

WHEN USING UNLIMITED MODE, SUBSTRATE CORRECTION RECOMMENDED FOR:

None

WHEN USING UNLIMITED MODE, SUBSTRATE CORRECTION <u>NOT</u> RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

WHEN USING SCREEN OR TEST MODE, FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

Drywall, Metal, and Wood

WHEN USING SCREEN OR TEST MODE, SUBSTRATE CORRECTION <u>NOT</u> RECOMMENDED FOR:

Brick, Concrete, and Plaster

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a <u>bare</u> substrate area covered with the red NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking three more readings on a second <u>bare</u>

substrate area of the same substrate covered with the red NIST SRM (1.02 mg/cm^2) paint film.

- Compute the correction value for each substrate type by computing the average of all six readings as shown below.

For each substrate type:

$$\left.\begin{matrix}\textit{Correction}\\ \textit{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \textit{Reading}}{6} - 1.02 mg/cm^2$$

- Repeat this procedure for each substrate tested in the house or housing development.

INCONCLUSIVE RANGE OR THRESHOLD:

XRF results are classified using either the threshold or the inconclusive range. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. For computing the XRF result, use all digits that are reported by the instrument. For the threshold, results are classified as positive if they are greater than or equal to the threshold, and negative if they are less than the threshold. There is no inconclusive classification when using the threshold. For the inconclusive range, results are classified as positive if they are greater than or equal to the upper limit of the inconclusive range, and negative if they are less than or equal to the lower limit of the inconclusive range. Thresholds and inconclusive ranges were determined for comparing results to the 1.0 mg/cm^2 standard. For a listing of laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for the analysis of samples to resolve an inconclusive XRF result or additional confirmational analysis, call the National Lead Information Center Clearinghouse on 1-800-424-LEAD.

UNLIMITED MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results not corrected for substrate bias for unlimited mode readings	Brick	0.9 to 1.2
	Concrete	0.9 to 1.2
	Drywall	0.9 to 1.2
	Metal	0.9 to 1.2
	Plaster	0.9 to 1.2
	Wood	0.9 to 1.2

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SCREEN MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results corrected for substrate bias for screen mode readings on drywall, metal, and wood substrates only	Brick Concrete Drywall Metal Plaster Wood	0.9 to 1.1 0.9 to 1.1 0.9 to 1.4 0.9 to 1.2 0.9 to 1.1 0.9 to 1.3

TEST MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Readings corrected for substrate bias for test mode readings on drywall, metal, and wood substrates only	Brick Concrete Drywall Metal Plaster Wood	0.9 0.9 None None 0.9 None	None None 0.9 to 1.4 0.9 to 1.1 None 0.9 to 1.3

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected. Use either 15-second readings or 60-second readings.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the average of the original and re-test result for each of the ten testing combinations.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

TESTING TIMES:

For screen, test, and confirm modes, the MAP 4 instrument tests until a K-shell result is obtained relative to a level of precision. A result is "positive", "negative" or "retest" as displayed by indicator lights. For the unlimited mode, the MAP 4 instrument tests until a K-shell result is indicated relative to an action level (1.0 mg/cm^2 for archive testing) and the current precision, or until the the reading is terminated by releasing the trigger. A few unlimited mode readings were terminated because they exceeded the two-minute limit used for archive testing. The following tables provide testing time information for three testing modes. Insufficient information is available to provide this information for confirm mode. All times have been scaled to match an initial 12 miC source. Note that source strength and factors such as substrate may affect testing times.

UNLIMITED MODE TESTING TIMES (Seconds)

SUBSTRATE[a]	ALL DATA			MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm^2)		
	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood Drywall	3	4	6	4	13	3
Metal	3	4	8	4	9	3
Brick Concrete Plaster	4	5	8	6	6	3

[a]The general calibration was used for wood, drywall, brick, concrete, plaster. Steel calibration was used for metal. (There are no aluminum samples in the archive facility).

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TESTING TIMES (continued):

SCREEN MODE TESTING TIMES (Seconds)						
SUBSTRATE[a]	**ALL DATA**			**MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm^2)**		
	25th Percentile	**Median**	**75th Percentile**	**Pb < 0.25**	**0.25 ≤ Pb < 1.0**	**1.0 ≤ Pb**
Wood Drywall	4	6	7	5	6	7
Metal	4	5	6	5	5	5
Brick Concrete Plaster	11	11	13	11	11	11

[a]The general calibration was used for wood, drywall, brick, concrete, plaster. Steel calibration was used for metal. (There are no aluminum samples in the archive facility).

TEST MODE TESTING TIMES (Seconds)						
SUBSTRATE	**ALL DATA**			**MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm^2)**		
	25th Percentile	**Median**	**75th Percentile**	**Pb < 0.25**	**0.25 ≤ Pb < 1.0**	**1.0 ≤ Pb**
Wood Drywall	17	22	27	21	20	28
Metal	13	20	23	20	20	20
Brick Concrete Plaster	41	42	52	41	46	43

[a]The general calibration was used for wood, drywall, brick, concrete, plaster. Steel calibration was used for metal. (There are no aluminum samples in the archive facility).

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BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with laboratory-measured lead levels less than 4.0 mg/cm^2 lead. There were 15 testing locations taken in the screen mode with a laboratory-measured lead levels equal to or greater than 4.0 mg/cm^2 lead. None of these had XRF readings less than 1.0 mg/cm^2. There were 15 testing locations taken in the test mode with a laboratory-measured lead levels equal to or greater than 4.0 mg/cm^2 lead. None of these had XRF readings less than 1.0 mg/cm^2. There were not any testing locations taken in the confirm mode with a laboratory-measured lead levels equal to or greater than 4.0 mg/cm^2 lead. There were 15 testing locations taken in the unlimited mode with a laboratory-measured lead levels equal to or greater than 4.0 mg/cm^2 lead. None of these had XRF readings less than 1.0 mg/cm^2. All testing was done in February 1996 with two different instruments. The following data are for illustrative purposes only. Actual bias must be determined on the site. Inconclusive ranges provided above already account for bias and precision. Units are in mg/cm^2.

SCREEN MODE READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	-0.1	0.3
	Concrete	-0.1	0.3
	Drywall	0.1	0.2
	Metal	0.1	0.3
	Plaster	-0.1	0.3
	Wood	0.0	0.2
0.5 mg/cm^2	Brick	0.0	0.3
	Concrete	0.0	0.3
	Drywall	0.3	0.4
	Metal	0.2	0.3
	Plaster	0.0	0.3
	Wood	0.2	0.4
1.0 mg/cm^2	Brick	0.1	0.4
	Concrete	0.1	0.4
	Drywall	0.5	0.6
	Metal	0.3	0.3
	Plaster	0.1	0.4
	Wood	0.4	0.6
2.0 mg/cm^2	Brick	0.4	0.5
	Concrete	0.4	0.5
	Drywall	0.9	0.8
	Metal	0.5	0.3
	Plaster	0.4	0.5
	Wood	0.7	0.8

*Precision at 1 standard deviation

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BIAS AND PRECISION (continued):

TEST MODE READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	-0.1	0.2
	Concrete	-0.1	0.2
	Drywall	0.1	0.1
	Metal	0.1	0.2
	Plaster	-0.1	0.2
	Wood	0.0	0.1
0.5 mg/cm^2	Brick	-0.1	0.3
	Concrete	-0.1	0.3
	Drywall	0.3	0.4
	Metal	0.2	0.2
	Plaster	-0.1	0.3
	Wood	0.2	0.4
1.0 mg/cm^2	Brick	-0.1	0.3
	Concrete	-0.1	0.3
	Drywall	0.5	0.6
	Metal	0.3	0.2
	Plaster	-0.1	0.3
	Wood	0.4	0.6
2.0 mg/cm^2	Brick	0.0	0.4
	Concrete	0.0	0.4
	Drywall	1.0	0.8
	Metal	0.5	0.2
	Plaster	0.0	0.4
	Wood	0.8	0.8

*Precision at 1 standard deviation

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St, S.W., Washington, DC 20410.

Table 1. Classification Results For Scitec MAP 4 K-Shell **UNLIMITED** Mode Readings (Uncorrected), Classified Using the Inconclusive Ranges Reported in the XRF Performance Characteristic Sheet and Compared to Laboratory-Measured Lead Levels in mg/cm^2 Classified Using the 1.0 mg/cm^2 Lead Federal Standard For Data Taken From Testing Archived Building Components in February 1996.

SUBSTRATE	INCONCLUSIVE RANGE OR THRESHOLD	FALSE POSITIVE RATE	FALSE NEGATIVE RATE	INCONCLUSIVE RATE
Brick	0.9 to 1.2	0.0% (0/2)	0.0% (0.4)	0.0% (0/6)
Concrete	0.9 to 1.2	0.0% (0/4)	(0/0)	0.0% (0/4)
Drywall	0.9 to 1.2	10.0% (3/30)	(0/0)	13.3% (4/30)
Metal	0.9 to 1.2	3.7% (2/54)	0.0% (0.22)	5.3% (4/76)
Plaster	0.9 to 1.2	3.4% (2/58)	0.0% (0/22)	1.3% (1/76)
Wood	0.9 to 1.2	9.0% (7/78)	0.0% (0/46)	5.6% (7/124)
TOTAL		6.2% (14/226)	0.0% (0/90)	5.1% (16/316)

Table 2. Classification Results For Scitec MAP 4 K-Shell **SCREEN** Mode Readings (Drywall, Metal, and Wood Corrected), Classified Using the Inconclusive Ranges Reported in the XRF Performance Characteristic Sheet and Compared to Laboratory-Measured Lead Levels in mg/cm^2 Classified Using the 1.0 mg/cm^2 Lead Federal Standard For Data Taken From Testing Archived Building Components in February 1996.

SUBSTRATE	INCONCLUSIVE RANGE OR THRESHOLD	FALSE POSITIVE RATE	FALSE NEGATIVE RATE	INCONCLUSIVE RATE
Brick	0.9 to 1.1	0.0% (0/2)	0.0% (0/4)	0.0% (0/6)
Concrete	0.9 to 1.1	0.0% (0/4)	(0/0)	0.0% (0/4)
Drywall	0.9 to 1.4	6.7% (2/30)	(0/0)	6.7% (2/30)
Metal	0.9 to 1.2	1.9% (1/54)	0.0% (0/22)	3.9% (3/76)
Plaster	0.9 to 1.1	3.4% (2/58)	0.0% (0/18)	0.0% (0/76)
Wood	0.9 to 1.3	7.7% (6/78)	0.0% (0/46)	4.8% (6/124)
TOTAL		4.9% (11/226)	0.0% (0/90)	3.2% (11/316)

Table 3. Classification Results For Scitec MAP 4 K-Shell **TEST** Mode Readings (Drywall, Metal, and Wood Corrected), Classified Using the Inconclusive Ranges and Threshold Value Reported in the XRF Performance Characteristic Sheet and Compared to Laboratory-Measured Lead Levels in mg/cm^2 Classified Using the 1.0 mg/cm^2 Lead Federal Standard For Data Taken From Testing Archived Building Components in February 1996.

SUBSTRATE	INCONCLUSIVE RANGE OR THRESHOLD	FALSE POSITIVE RATE	FALSE NEGATIVE RATE	INCONCLUSIVE RATE
Brick	0.9	0.0% (0/2)	0.0% (0/4)	0.0% (0/6)
Concrete	0.9	0.0% (0/4)	(0/0)	0.0% (0/4)
Drywall	0.9 to 1.4	6.7% (2/30)	(0/0)	10.0% (3/30)
Metal	0.9 to 1.1	1.9% (1/54)	0.0% (0/22)	1.3% (1/76)
Plaster	0.9	3.4% (2/58)	0.0% (0/22)	0.0% (0/76)
Wood	0.9 to 1.3	6.4% (5/78)	2.2% (1/46)	8.1% (10/24)
TOTAL		4.4% (10/226)	1.1% (1/90)	4.4% (14/316)

Table 4. Misclassification of Indicated Positive and Negative Results and Retest Percentages For Scitec MAP 4 K-Shell Readings (Uncorrected), Taken in **UNLIMITED**, **SCREEN**, and **TEST** Modes and **SCREEN-TEST-CONFIRM** Mode Sequence Compared to Laboratory-Measured Lead Levels in mg/cm^2 Classified Using the 1.0 mg/cm^2 Lead Federal Standard For Data Taken From Testing Archived Building Components in February 1996.

TESTING MODE	FALSE POSITIVE PERCENTAGE	FALSE NEGATIVE PERCENTAGE	RETEST PERCENTAGE
Unlimited mode	7.1%	0.0%	3.8%
Screen mode	5.1%	0.0%	15.8%
Test mode	6.6%	0.0%	7.0%
Screen-Test-Confirm mode sequence*	7.1%	0.0%	3.2%

*As indicated by the Operations Manual for the instrument.

These percentages were obtained from archive testing without applying substrate correction procedures, inconclusive ranges, or thresholds. These percentages can be compared to the corresponding percentages in Tables 1, 2, and 3.

The Screen-Test-Confirm mode sequence was applied in the following way. First, a screen mode reading was taken. If the result of the screen mode result was positive or negative, testing stopped and the screen mode result was the final reading. Otherwise, a test mode reading was taken. If the test mode result was positive or negative, then testing stopped, and the test mode result was the final reading. Otherwise, a confirm mode reading was taken. If the confirm mode result was positive or negative, the confirm mode result was the final reading. If the confirm mode result was indicated as "RETEST", the testing was terminated, and the final result was designated as "RETEST".